

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 1 045 144 A1

(12)

**EUROPEAN PATENT APPLICATION**

published in accordance with Art. 158(3) EPC

*NO-J377-EP 4-4000-1*

(43) Date of publication:

18.10.2000 Bulletin 2000/42

(51) Int. Cl.<sup>7</sup>: **F04B 35/00**

(21) Application number: 99949424.8

(86) International application number:

PCT/JP99/05909

(22) Date of filing: 26.10.1999

(87) International publication number:

WO 00/26538 (11.05.2000 Gazette 2000/19)

(84) Designated Contracting States:

AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE

(30) Priority: 29.10.1998 JP 30865298

(71) Applicant:

Bosch Automotive Systems Corporation  
Tokyo 150-8360 (JP)

(72) Inventors:

- IRIE, Kazuhiro,  
Zexel Corporation Konan Factory  
Konan-machi, Osato-gun, Saitama 360-0193 (JP)

• SAKURAI, Yukio,

Zexel Corporation Konan Factory  
Konan-machi, Osato-gun, Saitama 360-0193 (JP)

• NEGISHI, Yasutaka,

Zexel Corporation Konan Factory  
Konan-machi, Osato-gun, Saitama 360-0193 (JP)

• TAMEGAI, Masahiko,

Zexel Corporation Konan Factory  
Konan-machi, Osato-gun, Saitama 360-0193 (JP)

(74) Representative:

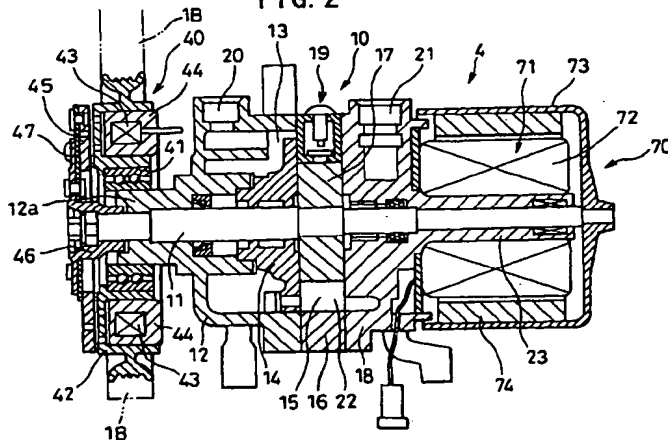
Patentanwälte Gesthuysen, von Rohr, Weidener,  
Häckel  
Postfach 10 13 54  
45013 Essen (DE)

(54) **HYBRID COMPRESSOR**

(57) A hybrid compressor achieving simplification in the structure and capable of driving the compression unit with ease is provided. An electromagnetic clutch unit (40) is provided at a rotating shaft (11) projecting out on one side of a compression unit (10) and an electric motor unit (70) is provided at the rotating shaft (11) projecting out on the other side of the compression unit (10), so that an electromagnetic clutch unit (40) in the prior art can be utilized directly. At the same time, since

the electric motor unit (70) is provided at the rotating shaft (11) projecting out the other side of the compression unit (10), the electromagnetic clutch unit and the electric motor unit are set at the same rotating shaft (11) and the compression unit (10) and the electric motor unit (70) are positioned next to each other to reduce the torsional torque generated at the rotating shaft (11).

FIG. 2



## Description

### TECHNICAL FIELD

[0001] The present invention relates to a hybrid compressor having two means for drive, that is employed in an air-conditioning system mounted in a hybrid vehicle which is driven by two means for drive, i.e., an internal combustion engine and an electric motor.

### BACKGROUND ART

[0002] The hybrid compressor disclosed in Japanese Unexamined Utility Model Publication No.H-87678 is provided with two drive sources, i.e., an engine and a battery-driven motor unit to drive the rotating shaft at the compression unit so that the rotating shaft at the compression unit is driven by either of the two drive sources that are selectively connected to the rotating shaft. In the hybrid compressor, the motor shaft of the motor is linked to the rotating shaft at the compression unit, and an electromagnetic clutch is provided between a pulley to which the motive power of the engine is communicated and a pulley to which the motive power of the rotating shaft is communicated, and either the rotating shaft or the motor shaft, so that the rotation of one of the pulleys is selectively communicated to the rotating shaft. The electromagnetic clutch is electrically connected in such a manner that by turning on the electromagnetic clutch, the motive power from the engine causes the rotor at the motor unit to rotate to charge the batteries and that, by turning off the electromagnetic clutch, the motor unit is caused to rotate on power supplied by the batteries.

[0003] However, the hybrid compressor described above having the electromagnetic clutch and the motor provided on one side of the rotating shaft at the compression unit necessitates a rotor constituting the motor and the armature of the electromagnetic clutch to be mounted as an integrated part of the rotating shaft with the stator of the electric motor jointly mounted at the supporting/retaining portion of the electromagnetic clutch, resulting in a highly complicated structure. In addition, as illustrated in FIG. 2 of the publication quoted above, when providing the motor on the outside of the electromagnetic clutch, the distance between the compression unit and the rotor of the motor increases, and this poses a problem in that the torsional torque occurring at the rotating shaft and the motor shaft causes damage to the retaining area over which the rotating shaft and the motor shaft are secured to each other. Furthermore, it is not desirable for a compressor mounted within the engine room to assume a structure having the motor unit projecting out beyond the electromagnetic clutch.

[0004] Accordingly, an object of the present invention is to provide a hybrid compressor that achieves sim-

plification in its structure and a higher degree of ease for driving the compression unit.

### DISCLOSURE OF THE INVENTION

[0005] In the hybrid compressor according to the present invention comprising a compression unit having a rotating shaft and a compression space, the volumetric capacity of which is varied through the rotation of the rotating shaft, a pulley mounted at the rotating shaft of the compression unit, to which the rotation of an internal combustion engine is communicated, an electromagnetic clutch that selectively connects the pulley to the rotating shaft to communicate the rotation of the internal combustion engine to the rotating shaft and an electric motor unit constituted of a rotor secured to the rotating shaft and a stator facing opposite the rotor. The rotating shaft passes through the compression unit, the electromagnetic clutch is provided at the rotating shaft projecting out on one side of the compression unit and the electric motor unit is provided at the rotating shaft projecting out on the other side of the compression unit in this hybrid compressor.

[0006] Thus, since the electromagnetic clutch is provided at the rotating shaft projecting out on one side of the compression unit and the electric motor unit is provided at the rotating shaft projecting out on the other side of the compression unit, an electromagnetic clutch in the prior art can be directly utilized. In addition, since the electric motor unit is provided at the rotating shaft projecting out on the other side of the compression unit, the electric motor and the electromagnetic clutch are provided at the same rotating shaft and the compression unit and the electric motor unit can be set adjacent to each other to achieve the object described above.

[0007] In addition, it is desirable that the hybrid compressor assume a structure of a rotary compressor in which the compression unit is constituted of a rotor secured to the rotating shaft and a compression space, the volumetric capacity of which is varied through the rotation of the rotor. The hybrid compressor should preferably be provided with a capacity-varying mechanism that varies the discharge quantity by varying the position at which the intake port opens during an intake process in which the compression space expands in response to the rotation of the rotor.

[0008] Alternatively, the hybrid compressor may assume a structure of a piston-type compressor in which the compression unit is provided with a plurality of cylinders formed along the direction of the axis of the rotating shaft and piston caused to engage in reciprocal movement inside the cylinders by the rotation of the rotating shaft. In this case, the hybrid compressor should preferably be provided with a capacity-varying mechanism that varies the discharge volume by varying the angle of a rotating inclined plate that causes the piston to move reciprocally within the cylinder as the rotating shaft rotates to limit the distance over which the

piston travels.

[0009] Since the rotary compressor and the piston-type compressor both assume a structure that accommodates the rotating shaft to pass through the compression unit and the presence of the capacity-varying mechanism enables control for reducing the startup torque, problems that would otherwise occur at the startup of the electric motor can be prevented.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### [0010]

FIG. 1 is a schematic block diagram illustrating an example of a freezing cycle which may be provided in the hybrid vehicle air conditioning system according to the present invention;

FIG. 2 is a sectional view of a first embodiment of the hybrid compressor;

FIG. 3 is a sectional view of a second embodiment of the hybrid compressor;

FIG. 4 is a sectional view of a third embodiment of the hybrid compressor; and

FIG. 5 is a sectional view of a fourth embodiment of the hybrid compressor.

#### BEST MODE FOR CARRYING OUT THE INVENTION

[0011] The following is an explanation of the embodiments of the present invention, given in reference to the drawings.

[0012] FIG. 1 illustrates an example of a freezing cycle in an air-conditioning system installed in a hybrid vehicle having two drive sources, i.e., an internal combustion engine 1 such as a gasoline engine, a diesel engine or the like and a battery-driven electric motor 2 for vehicle drive. This freezing cycle 3 comprises, at least, a hybrid compressor 4 to be detailed below and a condenser 5 that cools and condenses a coolant compressed by the hybrid compressor 4, an expansion valve 6 that adiabatically expands the coolant in a liquid-phase state after being condensed by the condenser 5 to set it in a gas-liquid mixed state, an evaporator 8 provided inside a duct 7 of the air-conditioning system, that absorbs the heat of the air passing through the duct 7 to evaporate the coolant set in the gas-liquid mixed state by the expansion valve 6 and an accumulator 9 that achieves gas-liquid separation for the coolant evaporated by the evaporator 8.

[0013] The hybrid compressor 4 is provided with a compression unit 10, a rotating shaft 11 passing through the compression unit 10, an electromagnetic clutch unit 40 provided at the rotating shaft 11 projecting on one side of the compression unit 10 and an electric motor unit 70 provided at the rotating shaft 11 projecting out on the other side of the compression unit 10.

[0014] The hybrid compressor 4 may assume the structure illustrated in FIG. 2, for instance. In the hybrid

compressor 4 in the first embodiment, the compression unit 10 is constituted of a front head 12 at which the electromagnetic clutch unit 40 is mounted and secured, a front side block 14 provided inside a low pressure space 13 formed inside the front head 12 to block one side of a compression space 15 to be detailed later along the axial direction, a cylinder block that defines, the compression space 15, a rotor 17 provided in the compression space 15 inside the cylinder block 16 to vary the volumetric capacity of the compression space 15 and a rear head 18 that blocks the other side of the compression space 15 along the axial direction. In addition, an intake port 20 communicating with the low pressure space 13 is formed at the front head 12, and a discharge port 21 communicating with a discharge valve mechanism 19 formed at the cylinder block 16 is formed at the rear head 18.

[0015] Thus, as the rotating shaft 11 rotates, the rotor 17 is caused to rotate inside the compression space 15 and a vane 22 provided at the rotor 17 travels along the internal circumferential surface of the cylinder block 16 to expand or contract the compression space 15. This causes the coolant to be taken in through the intake port 20 when the compression space 15 is expanded, and compresses the coolant when the compression space 15 is contracted to discharge the high-pressure coolant through the discharge port 21 via the discharge valve mechanism 19.

[0016] The electromagnetic clutch unit 40 provided at one end of the rotating shaft 11 is secured to a front end 12a of the front head 12 at the compression unit 10 via a bearing 41. At the external circumference of the bearing 41, a pulley 42 to be connected to a pulley 1a of the internal combustion engine 1 via a belt 1B is provided. The pulley 42, which is provided with an electromagnetic attraction portion 44 that is excited by a coil 43, rotates at all times while the internal combustion engine 1 is in operation.

[0017] An armature 45 is provided facing opposite the electromagnetic attraction portion 44. The armature 45 is linked to a hub 46 secured to the rotating shaft 11 via an elastic member 47 constituted of a plate spring or the like in such a manner that it can move freely along the axial direction, and is drawn to the electromagnetic attraction portion 44 which is excited when power is supplied to the coil 43 to link the pulley 42 and the hub 46 so that the rotation of the internal combustion engine 1 is communicated to the rotating shaft 11.

[0018] The electric motor unit 70, which is located on the side opposite from the electromagnetic clutch unit 40 across the compression unit 10, is constituted of a stator 71 formed at the rear head 18 of the compression unit 10 and secured to a motor mounting projection 23 through which the rotating shaft 11 passes and a rotor 73 secured to the end of the rotating shaft 11 passing through and extending out of the motor retaining projection 23. In this embodiment, the electric motor unit 70 is a brushless motor. A coil 72 that generates a

rotating magnetic field is wound around the stator 71 and the rotor 73 is provided with a permanent magnet 74 at a position facing opposite the stator 71. As a result, when power is supplied to the duct 72, a rotating magnetic field is generated at the stator 71, which causes an attraction / repulsion force to manifest at the permanent magnet 74 to cause the rotor 73 to rotate.

**[0019]** Thus, since the compression unit 10 is driven by the motive force of the internal combustion engine 1 by turning on the electromagnetic clutch unit 40 when the hybrid vehicle is driven by the internal combustion engine 1 and the compression unit 10 is rotated by the electric motor unit 70 by turning off the electromagnetic clutch unit 40 and supplying power to the electric motor unit 70 when the internal combustion engine 1 in the hybrid vehicle is stopped and the hybrid vehicle is driven by the electric motor 2 for vehicle drive, it is possible to prevent any excess load from being applied to the electric motor 2 for vehicle drive and to operate the compression unit 10 in a stable manner.

**[0020]** The following is an explanation of the other embodiments of the present invention, with the same reference numbers assigned to components having identical structural features or achieving identical functions to those in the first embodiment to preclude the necessity for repeated explanation thereof.

**[0021]** A hybrid compressor 4 illustrated in FIG. 3, which is a rotary compressor having a compression unit 10 structured similarly to that in the first embodiment, is provided with a capacity-varying mechanism.

**[0022]** This capacity-varying mechanism is constituted of a rotating plate 24 provided within an intake space 13A formed inside rear blocks 18A and 18B closing off the other side of the cylinder block 16 along the axial direction, which displaces the position of the intake port (not shown) communicating between the compression space 15 and the intake space 13A relative to the position of the compression space 15, a rod 25 provided to cause the rotating plate 24 to rotate and a displacement mechanism 26 that displaces the front end of the rod 25. When reducing the discharge quantity, the position at which the communication of the compression space 15 and the intake space 13A starts during the intake process is retarded, whereas the position at which the communication starts is advanced to increase the discharge quantity.

**[0023]** By providing the capacity-varying mechanism described above, the discharge capacity can be reduced during the initial period of drive effected by the electric motor unit 70 to reduce the drive torque imparted to the electric motor unit 70, thereby achieving smooth drive.

**[0024]** In the embodiment illustrated in FIG. 4, the compression unit 10 assumes a structure of a piston-type compressor instead of that of the rotary compressor described above. The compression unit 10 constituted as a piston-type compressor comprises a plurality of cylindrical compression spaces 27 formed along the

direction of the axis of a cylinder block 16A, a piston 28 that engages in sliding reciprocal movement inside the compression space 27, a rotating inclined plate 29 that cause the piston 28 to engage in reciprocal movement in the compression spaces 27 and a rotating plate 30 that causes the rotating inclined plate 29 to rotate while the rotating shaft 11 rotates.

**[0025]** In addition, a ball portion 31 which interlocks with the rotating inclined plate 29 is provided at a specific position near the external circumference of the rotating plate 30 that rotates as the rotating shaft 11 rotates, and the rotating inclined plate 29 is caused to rotate in response to rotation of the rotating shaft 11 via the ball portion 31. The rotating inclined plate 29 is provided with a contact sliding surface 34 which comes in contact with a moving shaft 32 to which the compression spaces 27 is linked, and the moving shaft 32 is placed in contact with the contact sliding surface 34 engages in reciprocal movement along the axial direction when the rotating inclined plate 29 rotates at an angle.

**[0026]** At the front surface of the compression space 27, a plate 18C having an intake port and a discharge port formed therein is clamped and secured between a rear head 18D and the cylinder block 16A. Furthermore, the cylinder block 16A is provided with a motor retaining projection 23 passing through and extending out of the rear head 18D to secure the stator 71 of the electric motor unit 70.

**[0027]** In the hybrid compressor 4 structured as described above, the capacity of the compression unit 10 is varied by moving a vertex 29A of the rotating inclined plate 29 with the ball portion 31 set as the fulcrum to change the inclining angle of the rotating inclined plate 29 and ultimately to change the distance over which the piston 28 travels. It is to be noted that FIG. 4 shows the rotating inclined plate 29 set at the position at which the discharge capacity is at the smallest.

**[0028]** The electric motor unit 70 of the hybrid compressor 4 shown in FIG. 5 is constituted of an electric motor having a brush 75 and a commutator 76. The electric motor unit 70 is constituted by winding a coil 74A for generating a magnetic field around a rotor 73A secured to the rotating shaft 11 and providing a stator 71A secured to the rear head 18 in an outward direction relative to the rotor 73A, with a permanent magnet 72A provided at the stator 71A at a position facing opposite the rotor 73A.

**[0029]** In addition, an electric motor unit 70, which invariably engages in rotation when the electromagnetic clutch unit 40 is turned on, may be utilized to rectify the electromotive force generated at the coils 72 and 74A in order to charge the battery for driving the electric motor 2 for vehicle drive and the electric motor unit 70.

## INDUSTRIAL APPLICABILITY

[0030] As explained above, in the hybrid compressor according to the present invention having an electromagnetic clutch unit for linking with the internal combustion engine for vehicle drive on one side of the compression unit and a battery-driven electric motor unit on the other side of the compression unit, an electromagnetic clutch in the prior art can be directly utilized to achieve a reduction in the number of required parts so that an improvement in the assemblability is achieved and that any increase in the production cost can be minimized. In addition, since the electric motor unit can be provided in the vicinity of the compression unit, any problems caused by torsional torque imparted to the rotating shaft can be eliminated.

[0031] Furthermore, since the electric motor unit is not incorporated into the electromagnetic clutch unit but assumes an independent structure instead, the electric motor unit is placed in direct contact with external air to improve the cooling performance and the motor efficiency. Moreover, since the discharge volume can be adjusted in conformance to the operating state of the electric motor unit by providing the capacity-varying mechanism, the motive power saving performance of the electric motor unit is improved.

## Claims

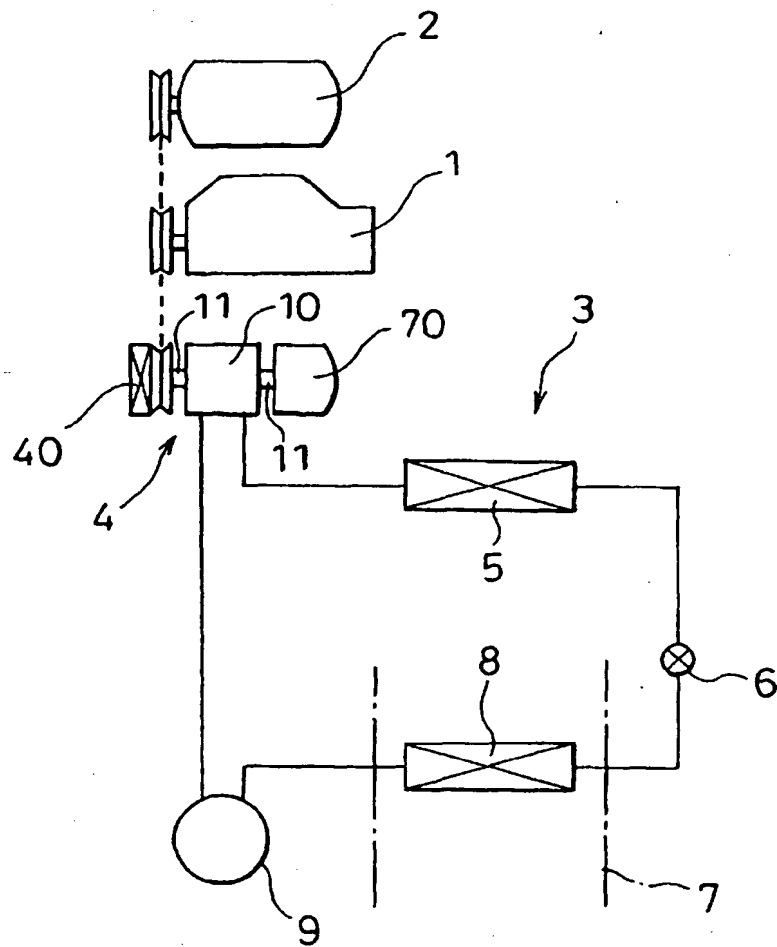
1. A hybrid compressor comprising;
  - a compression unit having a rotating shaft and a compression space, the volumetric capacity of which is varied through the rotation of said rotating shaft;
  - a pulley mounted at said rotating shaft of said compression unit, to which the rotation of an internal combustion engine is communicated;
  - an electromagnetic clutch that selectively connects said pulley to said rotating shaft to communicate the rotation of the internal combustion engine to said rotating shaft; and
  - an electric motor unit constituted of a rotor secured to said rotating shaft and a stator facing opposite said rotor, wherein;
  - said rotating shaft passes through said compression unit, said electromagnetic clutch is provided at said rotating shaft projecting out on one side of said compression unit and said electric motor unit is provided at said rotating shaft projecting out on another side of said compression unit.
2. A hybrid compressor according to claim 1, wherein;
  - said compression unit is a rotary compressor constituted of a rotor secured to said rotating shaft and a compression space, the volumetric

capacity of which is varied through the rotation of said rotor.

3. A hybrid compressor according to claim 2, wherein;
  - said compression unit is provided with a capacity-varying mechanism that varies the discharge quantity by varying the position at which an intake port opens during an intake process in which said compression space expands in response to the rotation of said rotor.
4. A hybrid compressor according to claim 1, wherein;
  - said compression unit is a piston-type compressor having a plurality of cylinders formed along the direction of the axis of said rotating shaft and piston caused to engage in reciprocal movement inside said cylinders by the rotation of said rotating shaft.
5. A hybrid, compressor according to claim 4, wherein;

said compression unit is provided with a capacity-varying mechanism having a rotating inclined plate for causing said piston to move reciprocally in said cylinder as said rotating shaft rotates, that varies the discharge volume by varying the angle of said rotating inclined plate to limit the distance over which said piston travels.

FIG. 1



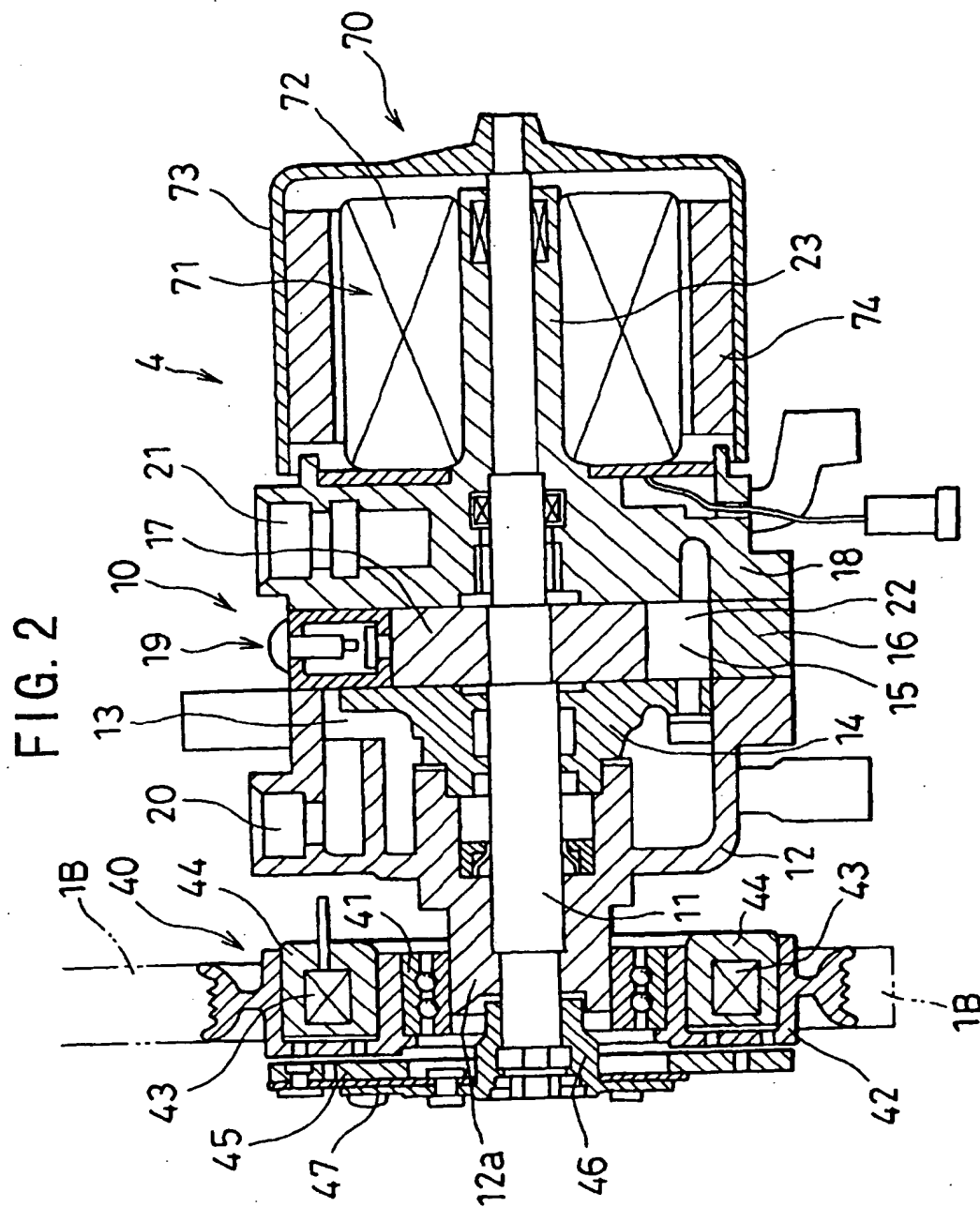
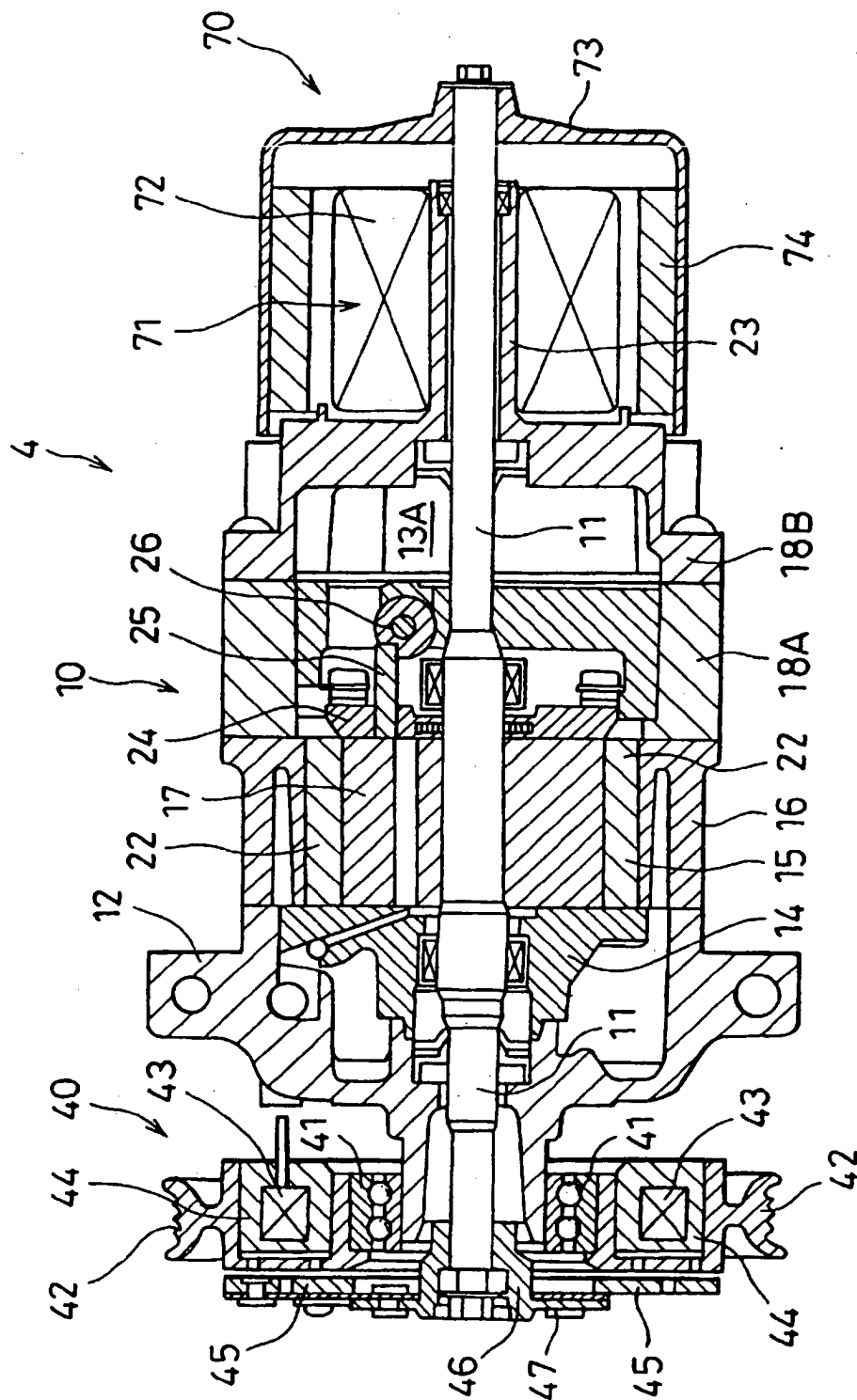


FIG. 3





**FIG. 4**

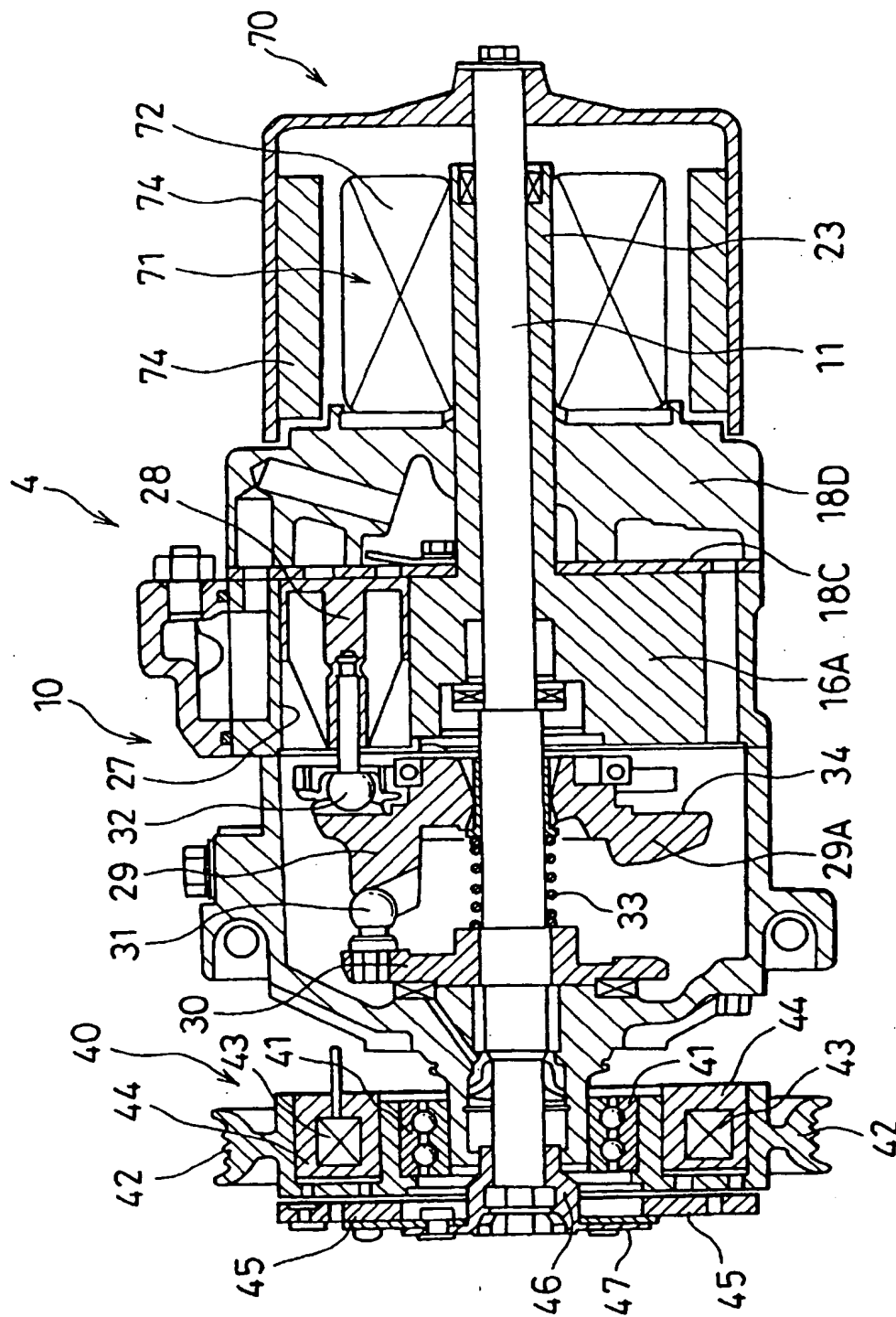
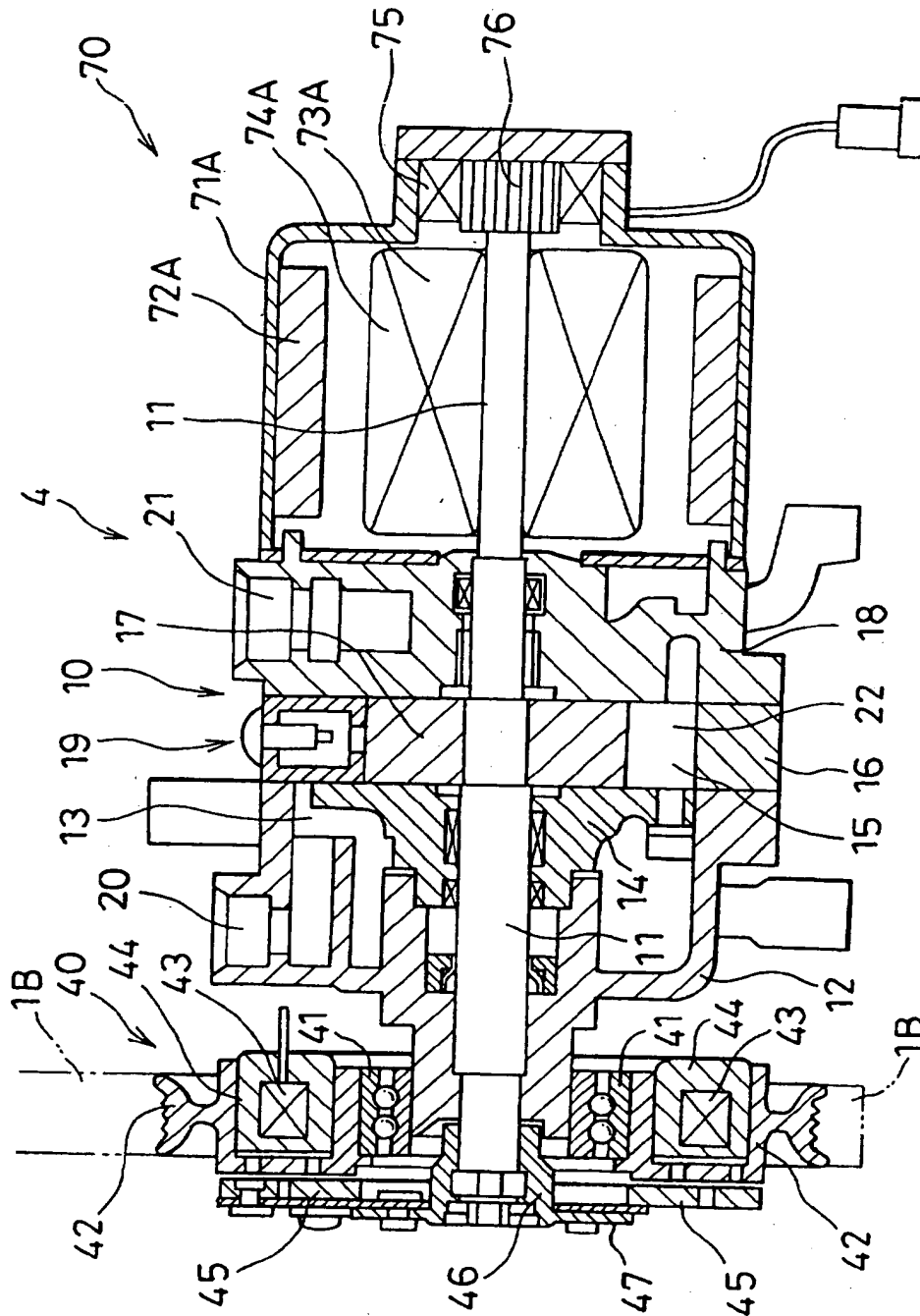


FIG. 5



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP99/05909

A. CLASSIFICATION OF SUBJECT MATTER  
Int.Cl.<sup>7</sup> F04B35/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl.<sup>7</sup> F04B35/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1926-1999	Toroku Jitsuyo Shinan Koho	1994-1999
Kokai Jitsuyo Shinan Koho	1971-1999	Jitsuyo Shinan Toroku Koho	1996-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 6-87678, U (CALSONIC CORPORATION), 22 December, 1994 (22.12.94) (Family: none)	1-5

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search  
18 January, 2000 (18.01.00)Date of mailing of the international search report  
08 February, 2000 (08.02.00)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (Julv 1992)

